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HES T0X-EPI REVIEW

HAZARD EVALUATION SECTION (COMMUNITY TOXICOLOGY UNIT)
OFFICE 0F ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

METHYL MERCURY IN NORTHERN COASTAL MOUNTAIN LAKES: GUIDELINES FOR SPORT FISH CONSUMPTION FOR CLEAR LAKE (LAKE COUNTY) LAKE BERRYESSA (NAPA COUNTY), AND LAKE HERMAN (SOLANO COUNTY)

by

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EXECUTIVE SUMMARY

Virtually all fresh and salt water fish contain mercury at some level in their flesh, including California fish, whether purchased commercially or caught as sport fish. The majority of the mercury is present in an organic form, usually as methyl mercury, which can be toxic to humans in sufficient quantity. Fish in the U.S. diet average about 0.3 parts per million (ppm) mercury, an amount that is not considered harmful, given normal consumption patterns. The U.S. Food and Drug Administration (FDA) and the California Department of Health Services (DHS) action level for commercially marketed fish is 1.0 ppm mercury, but this action level does not apply to sport fish. Although mercury is ubiquitous in our environment, it is not equally distributed. The northern coastal mountains of California are naturally rich in mercury-containing deposits which add to the mercury burden in the region's watersheds. Historical mining operations have contributed to this burden. Periodic sampling of fish conducted in the region since the 1970's has sometimes found sport fish in excess of the 1.0 ppm action level for commercial fish, raising the question whether eating sport fish from the region would be harmful. DHS, in conjunction with the Department of Fish and Game, has issued guidelines for sport fish consumption in a number of areas around the State. This is the most recent set of recommendations to be issued, addressing mercury concerns in three northern California counties.

This report describes our recommended dietary consumption guidelines for sport fish in three lakes in northern coastal California: Clear Lake in Lake County, Lake Berryessa in Napa County, and Lake Herman in Solano County. The report details the origins of methyl mercury in fish, the procedures by which the levels of mercury in fish were accurately characterized, the toxicological considerations of human exposure to methyl mercury, and the derivation of the guidelines for consumption of various species of sport fish from the different lakes.

The mercury data for sport fish in these lakes is summarized in Table 2 (page 13). The recommended fish consumption guidelines are listed in Table 5 (page 16). The average levels in some of the sport fish are mildly elevated, ranging up to about 3 times the national dietary average, but still below the FDA action level of 1.0 ppm. Average levels in larger specimens of certain species (e.g. largemouth bass and channel catfish) tended to exceed the action level, leading to size-based consumption recommendations for these species. Some of the species are as low or lower than the national dietary average. On balance, the range of concentrations in the fish in these lakes are well within the range observed in commercial fish harvested in the U.S. (see Table 3, page 14).

It is important to keep the mercury concern in perspective. Dietary exposure to mercury is inevitable if one eats fish, regardless of the source. Whether consumption is harmful depends on the concentration and amount of fish eaten over an extended period of time. These guidelines provide consumers the information to make healthy choices about the amount of sport fish they eat from these lakes. Rather than avoiding these lakes which have been well studied, consumers should be heartened by the fact that if our guidelines are followed, year-around residents may eat these fish regularly for a lifetime

without harm. Obviously, tourists who have short term exposure do not need to be concerned provided the guidelines are followed.

INTRODUCTION

The coastal mountains of Northern California are naturally rich in mercury-containing cinnabar ores. Miners also used mercury amalgam to extract gold from ore in mining operations, which added to easily mobilized deposits of mercury in the watersheds of the coastal mountains. A number of streams and bodies of water in this region have mercury-containing sediments at levels higher than the "background" level for California. In some instances, mercury containing sediments are considerably higher than background.

The inorganic mercury in the sediments finds its way into living organisms in the sediments, where it is converted to an organic chemical called methyl mercury. Methyl mercury bioaccumulates in aquatic organisms and tends to increase in concentration further up the food chain, particularly among shellfish and fish.

Since the early 1970's, when the first systematic surveys were done, fish in this region have been known to have higher levels of methyl mercury than background levels for fish in other regions of California. In areas where fish have been found to consistently exceed the U.S. Food and Drug Administration (FDA) action level for mercury of 1 part per million (ppm), steps have been taken to restrict or prohibit fish consumption. For instance, certain lakes and streams have been closed to fishing, and, for certain others, guidelines have been issued on how frequently fish may be eaten.

Periodic testing of Clear Lake fish during this time had revealed some fish with methyl mercury levels in excess of the FDA action level and raised the question whether Clear Lake fish contained enough methyl mercury to warrant guidelines for restricting consumption. As has been the case for other instances of potential contamination of fish, the California Department of Fish and Came (DFG) asked the California Department of Health Services (DHS) to evaluate the situation and to make health-related recommendations. At about the same time, local citizen interest led the Lake County Director of Environmental Health to convene an ad hoc committee called the Mercury Task Force to advise the county on the issue. The various agencies involved agreed that the county health department's committee should serve as a forum for discussion and to provide for public input and information. The Lake County Board of Supervisors gave its full support to the effort to better characterize methyl mercury concentration of fish.

Following the experience with Clear Lake fish, the Yountville Regional Office of DFG reviewed data from a number of lakes in the region and identified Lake Berryessa in Napa County and Lake Herman in Solano County as additional candidates for systematic sampling for methyl mercury in fish.

This report summarizes what has been learned about methyl mercury contamination in fish from these three lakes and describes the DHS recommendations to the Department of Fish and Game for fish consumption guidelines. This report also includes a summary of our updated review of the toxicological basis for methyl mercury dietary guidelines.

FISH SAMPLING METHODOLOGY

We initially designed a statistically valid sample of the fish populations in Clear Lake based on the appropriate environmental and biological considerations and arrangements were made for collecting and analyzing the specimens. The following items summarize the relevant aspects of the study methodology:

1) The Sulfur Bank Mine at the east end of the Oaks Arm of the lake was an apparent local source for mercury contamination of the lake sediments.

2) The sport fish of interest for Clear Lake are largemouth bass, channel catfish, white catfish, brown bullhead (often called mudcat), crappie (both black and white species), hitch (caught principally by the Elem Indian Colony), and Sacramento blackfish (a species fished commercially).

3) Largemouth bass are extremely territorial, usually staying within one-quarter mile of their local haunt. Hence distinct populations are found in each of the three arms of the lake. Bass fishing contests, however, result in some largemouth bass being caught in one part of the lake and being released in other parts of the lake.

4) The other species are thought to roam freely throughout the lake, and can be considered single lake-wide populations.

5) The longer a fish lives, the greater the likely accumulation of methyl mercury. See Table I for a list of fish species and their corresponding longevity.

6) For any given species, a high correlation exists between age and forklength (measured from the tip of the head to the fork of the tail).

7) Fish near the top of the food chain ("top predators," or higher trophic fish) tend to bioaccumulate more methyl mercury than fish lower on the food chain ("prey species," or lower trophic fish). See Table I for a list of fish species and their corresponding trophic level.

8) For each population of each species, a sample size of at least 20 specimens of varying lengths should allow: (a) an accurate estimate of average methyl mercury concentration; an estimate of the degree of variability in methyl mercury concentration: (b) and an analysis of the correlation between fish forklength and methyl mercury concentration.

9) Testing for organic mercury specifically is much more difficult than testing for combined organic and inorganic forms of mercury as "total" mercury. Since 90% or more of total mercury in fish is in the organic methyl mercury form, the fish samples (edible meat from fish fillets) were analyzed for total mercury content. The value obtained was assumed to reflect the methyl mercury concentration for purposes of establishing the fish consumption guidelines.

10) The Department of Fish and Came collected the fish specimens and analyzed them in their Water Pollution Control Laboratory for total mercury concentration by atomic absorption spectrophotometry.

Similar considerations were used to design the sampling for Lake Berryessa and Lake Herman. Although there was no obvious point source of mercury contamination, both lakes have histories of mercury mining in their watersheds. For Lake Berryessa, the sport fish of interest were channel catfish, white catfish, largemouth bass, smallmouth bass, and rainbow trout. For Lake Herman, only largemouth bass were tested.

ACCEPTABLE DAILY INTAKE OF METHYL MERCURY

A variety of national and international organizations have established guidelines and action levels for methyl mercury in fish in the human diet. The National Academy of Sciences has recommended a level of 0.5 ppm, while the U.S. FDA and DHS have established a regulatory action level for commercial fish of 1 ppm. No action levels have been established for sport fish and DHS does not enforce either the NAS guideline or the commercial action level for sport fish. When elevated levels of methyl mercury are found in sport fish in certain waters, one can either ban fishing from those waters or recommend guidelines on how much fish it would be acceptable to consume from those waters.

To provide an up-to-date assessment of methyl mercury hazards, DHS has studied the regulatory basis for the FDA action level, and has reviewed the relevant published toxicological literature on methyl mercury in fish. This detailed literature review may be requested from DHS. Its salient findings are summarized below:

1) The most toxic form of mercury is methyl mercury. The most conservative assumption for fish consumption guidelines would be that 100% of mercury in fish is methyl mercury.

2) The great majority of human exposure to methyl mercury comes from seafood in the diet, especially fish. Other sources such as air and water contribute a negligible amount. Most fish contain some methyl mercury.

3) Methyl mercury is toxic to both the central and peripheral nervous system, and is particularly toxic to the fetus during development.

4) Toxicity is dose-dependent. Studies of accidental human poisonings indicate the earliest consistent symptom of methyl mercury poisoning to be paresthesia (usually decreased sensation in the extremities). It typically occurs at blood mercury levels around 200 ng Hg/ml and above in non-pregnant adults. Pregnant women and their fetuses may be up to four times more sensitive.

5) A concentration of 200 ng Hg/ml blood constitutes a lowest-observed- effect level for methyl mercury toxicity in non-pregnant adults. For a 70-kg man, a constant daily intake of 0.3 mg methyl mercury would result in a blood mercury level of 200 ng Hg/ml.

6) At levels somewhat below 200 ng Hg/ml, clear evidence of an adverse effect is difficult to detect in non-pregnant adults. Most people have a detectable level of blood mercury, but below a certain level, no adverse effects are expected. A blood mercury level one tenth that of the

lowest-observed-effect level is unlikely to be associated with adverse effects, and should therefore represent an acceptable level.

7) Adult: The application of a safety factor of 10 to the lowest-observed-effect level in non-pregnant adults results in an Acceptable Daily Intake (ADI) of 30 ug per day for a 70-kg adult, or 0.4 ug/kg body weight.

8) Pregnancy: The developing fetus is definitely more susceptible to the toxic effects of methyl mercury than the adult. Pregnant women appear to be somewhat more sensitive than the non-pregnant adult, as well. Available data suggest an additional 4-fold safety factor to be prudent to protect the developing fetus. Pregnant women, and women who may soon become pregnant, should limit their mercury intake to 0.1 ug/kg per day, or one-quarter that allowed for other adults. Methyl mercury is excreted in breast milk, so nursing mothers should follow this same guideline.

9) Children - Newborn and young children continue to experience rapid development of the nervous system. By around age five, however, the brain has grown to nearly adult weight. The data on methyl mercury effects in young children do not indicate at which point young children became similar to adults in their sensitivity to methyl mercury. It would be prudent to assume that until brain growth has stabilized at age six, children age five and under are more susceptable to methyl mercury and should follow the guidelines for fetal development during pregnancy, or an ADI of 0.1 ug/kg per day. By age six, the adult ADI of 0.4 ug/kg should provide an adequate margin of safety.

10) Methyl mercury is metabolized quite slowly in the body and has a half-life of more than two months. This means that short-term fluctuations (on a daily or weekly basis) in dietary intake affect blood mercury slowly. Although we have recommended an Acceptable Daily Intake, it makes more sense biologically to think of methyl mercury intake in terms of acceptable monthly intake. Our fish consumption guidelines, therefore, will be expressed on a monthly basis.

METHYL MERCURY LEVELS IN SPORT FISH

Clear Lake

In November 1985, the Central Valley Regional Water Quality Control Board provided an excellent summary of environmental data pertaining to mercury in Clear Lake sediments, waters, aquatic life, and waterfowl in its "Summary of Mercury Data Collection at Clear Lake," copies of which were sent to DFG, DHS, and the Mercury Task Force. The report includes a listing of the test results on individual fish by species and date, which provided the analytical basis for the DHS recommendations.

Although our initial hypothesis was that only largemouth bass might show a regional variation for different areas in the lake, we tabulated the fish data by region of the lake, when applicable, to verify our hypothesis. Table 2 summarizes the fish data by region for Clear Lake and for the other lakes. No practical differences exist among the arms of the lake, except for largemouth

bass. Largemouth bass from the Oaks Arm are clearly higher. Although largemouth bass in the Lower Arm average somewhat lower than largemouth bass in the Upper Arm, the difference is not statistically significant.

Largemouth bass in the Oaks Arm sample have the highest average mercury concentration of any species tested, geometric mean - 0.82 ppm, with a 95% upper confidence interval on the mean of 0.97 ppm, just under the FDA 1 ppm Action Level. For this dataset, the difference between arithmetic means and geometric means was small, but analysis showed that geometric means fit the data better.

An important consideration is that the legal catch size for largemouth bass is 12 inches or larger (corresponding to a fork length of 285 mm), which would skew the average mercury concentration among fish of legal size toward higher values, since there is a strong correlation between size and mercury level.

All three top trophic species (largemouth bass, channel catfish, and crappie) tended to exceed the FDA Action Level in larger specimens (Table 2). The apparent relationship observed for the 4 specimens of middle trophic white catfish from the Upper Arm does not hold for the larger sample in the Oaks Arm, where the correlation between size and mercury concentration was nearly zero. The data for crappie is somewhat equivocal because of lower correlations and the presence of a few "outlying" values in the data set that skew the predicted mercury level upward. Nevertheless, to be relatively sure, on average, that a given fish does not exceed the FDA Action Level, one would want to avoid fish greater than 15 inches for largemouth bass, 24 inches for channel catfish, and 12 inches for crappie.

Aside from largemouth bass in the Oaks Arm and the above size considerations, the remainder of the fish in Clear Lake fall into two basic categories:

1) Upper to middle trophic fish with mean mercury concentrations ranging from 0.4 to 0.5 ppm, and

2) Middle to lower trophic fish, with mean mercury concentrations ranging from 0.2 to 0.3 ppm.

Compared to U.S. data on freshwater catfish and crappie in Table 3, these upper trophic fish in Clear Lake likely have 2 to 3 times the "normal" amount of mercury expected for their species. Few lakes in California, however, have been as thoroughly tested. With the exception of the larger specimens of the top trophic species, the mercury concentrations in Clear Lake fish are comparable to or lower in mercury than a number of species of commercial and sport fish in the U.S. (See Table 3).

The data in Table 3 are from a large study of a total of 18,904 fish samples. The average values for several species, e.g., sharks (1.24 ppm), swordfish (1.27 ppm), and tilefish (1.61 ppm) exceed the FDA action level. Other commonly eaten species, such as striped bass (0.75 ppm), marine catfish (0.48 ppm), groupers (0.60 ppm), red snapper (0.45 ppm), and freshwater trout (0.42 ppm) were more typical of the levels found in Clear Lake fish. Using the findings reported in the study, the average level of mercury in the commercial fish species comprising the U.S. diet is calculated to be 0.3 ppm, which on

average should allow thirteen 8 oz. seafood servings per month for non-pregnant adults, and three servings per month for pregnant and lactating women and children under age 6. Consumers would be well advised, in general, to adjust their fish consumption to take into account the wide range of mercury concentrations in various species from various locations, not only for fish from Clear Lake, but for commercial fish as well.

Lake Berryessa

White catfish had the highest geometric mean level of mercury (0.75 ppm Hg) of the species tested in Lake Berryessa. In contrast to the channel catfish in Clear Lake, mercury levels in Lake Berryessa channel catfish did not correlate with size, although average mercury levels were about the same. Levels in largemouth bass were comparable to those in the Lower Arm of Clear Lake, except for the Pope Creek area where only 11 fish were sampled. Although the mean level In smallmouth bass was a low 0.23 ppm Hg, the strong correlation with size means that specimens over 12" (the legal catch size limit) are likely to exceed 1.0 ppm Hg. Rainbow trout were a low 0.17 ppm Hg.

Lake Herman

Largemouth bass in Lake Herman had the highest geometric mean mercury level (0.92 ppm Hg) of any species in any of the three lakes. Any fish above the legal catch size of 12 inches is likely to exceed 1.0 ppm Hg.

FISH CONSUMPTION GUIDELINES

Methyl mercury ingestion from fish is a function of several parameters, including: the methyl mercury concentration in the fish; the size of the portion consumed; the frequency of consumption; and the contribution of methyl mercury from other sources (such as commercial fish, air, etc.). Several assumptions were made to simplify the calculations:

1) The contribution from sources other than fish and shellfish to human methyl mercury body burdens is negligible.

2) A fish meal of sport fish is a substitute for, rather than in addition to, normal fish in the diet that comes from other sources.

3) Of the measured mercury in sport fish, 100 percent is methyl mercury.

4) The typical portion size in a sport fish meal is eight ounces (uncooked) for a 70-kg adult. People, including children, weighing less or more than 70-kg were assumed to eat fish portions in proportion to their weight. For example, a 35-kg child would be expected to eat 4 oz. portions, and a 96-kg adult would be expected to eat 11 oz. portions. These typical fish portions equate to about 3 grams of fish per kilogram of human bodyweight per fish meal (3 g/kg bodyweight)

Example calculation for a 70-kg man:

Fish portion = 225 g = 8 oz.

Hg concentration in fish = 1 ppm = 1 ug/g

Therefore:

Hg intake from 225 g fish @ 1 ppm = 225 ug Hg

The ADI = 30 ug/day for a 70-kg man

Based on the ADI, an acceptable monthly intake would be:

30 ug Hg/day x 30 days = 900 ug Hg/month

One can calculate an acceptable monthly fish intake as follows:

$$\frac{\text{900 ug Hg/month}}{\text{225 ug Hg/meal}} = \text{four 8-oz fish meals/month @ 1 ppm Hg (equivalent to 2 pounds/month)}$$

As shown in the above example, at an ADI of 30 ug, one could eat four 8-oz. fish meals per month containing 1.0 ppm Hg and not exceed the allowable monthly intake. Similarly, for fish containing 0.5 ppm, one could eat 8 meals per month, and for fish containing 2.0 ppm, only 2 meals per month. Depending on the fish species, size and location, there is more than a 10-fold variation in mercury concentration among fish in these three lakes. Table 4 depicts the impact that mercury concentration has on the allowable number of meals per month, ranging from zero to 40 meals. Since cumulative monthly exposure is the concern, it is clear that the mercury dose from each meal needs to be added up to arrive at a monthly exposure total which should stay below the appropriate acceptable monthly intake. Furthermore, the allowable exposure from one species has to offset the exposure from another species as both count toward the monthly total intake. While it is possible to "mix and match" different numbers of meals of different species to stay within the acceptable monthly intake, it is difficult to communicate this concept to consumers and it is difficult for them to apply this concept to their fishing practices. For this reason, we simplified the guidelines but at the same time we purposefully made them more conservative than they would be if it were reasonable to expect consumers to keep track of cumulative monthly mercury exposure.

Based on the above considerations and the data on mercury distribution in sport fish in the three lakes, we have chosen to express our recommended fish consumption guidelines as the number of pounds allowed per month, as shown in Table 5. We have made the recommendations as straightforward as possible, taking into account the variability among the different species. Even though pregnant women and children under age 6 could safely consume reduced quantities of sport fish from these lakes, many may already be approaching their ADI from commercial fish consumption and thus may exceed their ADI if a meal were to contain a large proportion of their monthly "quota". Even though the lower trophic species such as hitch and Sacramento blackfish from Clear Lake or rainbow trout from Lake Berryessa probably contain less mercury than the national dietary average, we felt that the advisory would be easier to remember and follow if all species were included in the advisory. We recommend,

therefore, that pregnant women, women who may soon become pregnant, nursing mothers, and children under age 6 avoid fish from these three lakes.

Tourists who visit these lakes for only a few weeks out of the year should have little concern for the mildly elevated levels of mercury present in some species of sport fish. Provided that they are not elsewhere exposed to fish with elevated mercury levels, no harm should result, for instance, in incurring the equivalent of a one month acceptable intake during a one- or two-week visit. Tourists who are pregnant or who are very young children should still, of course, avoid fish from these lakes.

The guidelines are specifically designed for people who eat fish year-round and, if followed, should prevent any adverse health consequences from methyl mercury. People wishing to restrict their mercury intake even further, but still eat fish from the lake, could avoid largemouth bass from the Oaks Arm of Clear Lake and white catfish from Lake Berryessa and eat less of the higher trophic species in general, especially larger specimens. Conversely, highly motivated consumers may want to use the data in Tables 2, 3, and 4 to calculate their personal mercury exposure and adjust their consumption accordingly. Practically speaking, this level of detail is difficult to communicate in the format typical for fishing regulations. We believe the monthly consumption guidelines format to be the best compromise.

Waterfowl

The Department of Fish and Game collected 20 specimens each of coots and grebes from Clear Lake. No significant mercury contamination existed in coots, as expected, since coots are primarily vegetarian. Grebes, however, eat a lot of fish, and, not surprisingly, were significantly contaminated with mercury. Average concentrations of 6.4 ppm Hg were found in liver (range 3.7 - 9.8 ppm) and 2.0 ppm Hg in breast muscle (range 0.4 - 3.3 ppm). Grebes are not legal to hunt, but if they were, we would recommend that grebe liver and other organ meat be discarded, and that grebe not be eaten more than once per month. Pregnant and lactating women and children under age 6 should avoid grebe. In the absence of data on other species of fish-eating waterfowl, such as mergansers, which are legal to hunt, this would probably be good advice for other species of fish-eating waterfowl that feed regularly from any of the three lakes. One meal of such waterfowl should substitute for at least two meals of fish, and the consumption of such waterfowl and fish should be adjusted accordingly.

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TABLE I

PRINCIPAL SPORT FISH SPECIES

Fish Species	Trophic Level	Lifespan	Lake[1]
Largemouth bass	Top	Long (12-13 yrs)	CL, LB, LH
Channel catfish	Top	Long (9-10 yrs)	CL, LB
Smallmouth bass	Top	Medium (4-7 yrs)	LB
Crappie, black & white	Top	Medium (4-7 yrs)	CL
Rainbow trout	Top	Short (1-3 yrs)	LB
White catfish	Middle	Long (9-10 yrs)	CL, LB
Brown bullhead	Middle	Long (9-10 yrs)	CL
Sacramento blackfish	Low	Medium (5-6 yrs)	CL
Hitch	Low	Medium (5-7 yrs)	CL

[1] CL - Clear Lake (Lake County)
LB - Lake Berryessa (Napa County)
LH - Lake Herman (Solano County)

TABLE 2: MERCURY IN SPORT FISH BY SPECIES BY LAKE BY LOCATION CAUGHT

FISH SPECIES Lake	- Location caught	Number of Fish tested	Geometric mean mercury concentration ppm)	95% Confidence interval on the geometric mean (ppm)	Correlation of mercury w/ fork-length	Fork-length at which 95%upper confidence interval exceeds 1.0 ppm
LARGEMOUTH BASS						
Clear Lake[1]	- Oaks Arm	24	0.82	0.69-0.97	0.79	15
	- Upper Arm	24	0.48	0.42-0.54	0.85	18
	- Lower Arm	30	0.37	0.31-0.44	0.51	20
	- Total	78				
Clear Lake[2]	- Oaks Arm	46	0.61	0.52-0.71	0.79	15
	- Upper Arm	38	0.37	0.32-0.43	0.85	18
	- Lower Arm	31	0.37	0.31-0.43	0.51	20
	- Total	115	0.45	0.41-0.50	0.52	
Lake Berryessa	- Putah Creek	19	0.37	0.26-0.53	0.91	15
	- Capel Creek	21	0.19	0.13-0.29	0.77	15
	- Pope Creek	11	0.63	0.52-0.77	0.73	13
	- Total	51	0.32	0.25-0.40	0.82	15
Lake Herman	- Total	10	0.92	0.74-1.14	0.77	12
SMALLMOUTH BASS						
Lake Berryessa	- Total	14	0.23	0.17-0.31	0.90	12
CHANNEL CATFISH						
Clear Lake	- Oaks Arm	18	0.41	0.28-0.62	0.81	25
	- Upper Arm	10	0.46	0.33-0.66	0.86	24
	- Total	28	0.43	0.32-0.58	0.82	
Lake Berryessa	- Putah Creek	51	0.56	0.51-0.61		
	- Capel Creek	17	0.36	0.28-0.45		
	- Pope Creek	19	0.57	0.49-0.67		
	- E. Smoke Vinyard	20	0.43	0.35-0.43		
	- Total	107	0.50	0.46-0.54	-0.20	None
WHITE CATFISH						
Clear Lake	- Oaks Arm	21	0.54	0.48-0.61	0.01	None
	- Total	26	0.53	0.47-0.59	0.08	
Lake Berryessa	- Total	22	0.75	0.69-0.81	-0.12	None
BLACK AND WHITE CRAPPIE						
Clear Lake	- Oaks Arm	25	0.38	0.31-0.46	0.22	12
	- Upper Arm	26	0.38	0.32-0.44	0.54	15
	- Total	51	0.38	0.33-0.43	0.30	
BROWN BULLHEAD						
Clear Lake	- Oaks Arm	20	0.26	0.22-0.30	0.58	None
	- Total	26	0.25	0.21-0.29	0.47	
SACRAMENTO SLACKFISH						
Clear Lake	- Upper Arm	20	0.25	0.21-0.29	0.36	None
RAINBOW TROUT						
Lake Berryessa	- Total	29	0.17	0.15-0.18	-0.19	None
HITCH						
Clear Lake	- Upper Arm	20	0.15	0.12-0.17	-0.06	None
	- Total	21	0.15	0.12-0.17	-0.03	

[1]Values given are only for largemouth bass above legal catch size of 12 inches.
[2]Values given are for all largemouth bass, regardless of size.

Table 3

Mercury Concentrations in U.S. Commercial Seafood (ppm)

Species	Number Tested	Average Weight (gm)	Average Mercury	Maximum Mercury Value Observed
Bass, sea	53	346	0.16	0.58
Bass, striped	231	4378	0.75	2.00
Bluefish	94	1005	0.38	1.23
Catfish, freshwater	35	1480	0.15	0.38
Catfish, marine	81	754	0.48	1.20
Crappie	212	289	0.20	1.39
Flounders	1179	606	0.10	0.88
Groupers	928	6197	0.60	2.45
Halibut, Pacific N.W.	108	17163	0.53	1.43
Lobster, northern	1199	1429	0.51	2.31
Salmon	806	4077	0.05	0.21
Sharks	588	8320	1.24	4.53
Shrimp	353	15	0.05	0.33
Snapper, red	759	822	0.45	2.17
Swordfish	115	47639	1.27	2.72
Tilefish	61	5281	1.61	3.73
Trout, freshwater	528	4432	0.42	1.22
Trout, marine	201	676	0.24	1.19
Tuna, light skipjack	70	3412	0.14	0.39
Tuna, light yellowfin	115	29051	0.27	0.87
Tuna, white	76	9532	0.35	0.90

(Data from U.S. Department of Commerce "Report on the Chance of U.S. Seafood Consumers Exceeding the Current Acceptable Daily Intake for Mercury and Recommended Regulatory Controls," 1978).

TABLE 4

MERCURY EXPOSURE AS A FUNCTION OF CONCENTRATION IN FISH

COMPARED TO ACCEPTABLE MONTHLY INTAKE

Mercury Concentration in Fish (ppm)	Exposure (dose) per meal[1] (ug Hg/kg)	# meals which would not exceed 12 ug/kg monthly intake[2]	# meals which would not exceed 3 ug/kg monthly intake[3]
2.0	6.0	2	0
1.5	4.5	2	0
1.3	3.9	3	0
1.0	3.0	4	1
0.9	2.7	4	1
0.8	2.4	5	1
0.7	2.1	5	1
0.6	1.8	6	1
0.5	1.5	8	2
0.4	1.2	10	2
0.3	0.9	13	3
0.2	0.6	20	5
0.1	0.3	40	10

1). Consumption per meal is assumed to be 3 grams of fish/kg bodyweight for all ages (equivalent to an 8 oz meal for a 70-kg man).

Example calculation: 1 ppm = 1 ug Hg/gm fish

3 gm fish/kg bodyweight x 1 ug Hg/gm fish = 3 ug Hg/kg body weight

A meal that contained a dose of 3 ug Hg/kg bodyweight would represent 25% of the adult acceptable monthly intake of 12 ug/kg and 75% of the acceptable monthly intake during pregnancy. See footnotes 2 and 3 below.

2). Based on the ADI of 0.4 ug/kg for age six and older, the acceptable monthly intake for this group would be 30 days x 0.4 ug/kg per day or 12 ug/kg.

3). Based on the ADI of 0.1 ug/kg for pregnant and lactating women and children under age 6, the acceptable monthly intake for this group would be 30 days x 0.1 ug/kg per day or 3 ug/kg.<

TABLE 5

RECOMMENDED FISH CONSUMPTION GUIDELINES FOR SPORT FISH

Because of mercury levels in fish, women who are pregnant or who may soon become pregnant, nursing mothers, and children under age 6 should not eat fish from the lakes listed below. Adults should eat no more than the amount indicated below. Children 6-15 years of age should eat no more than one-half the amount indicated.

Clear Lake (Lake County)

Largemouth bass over 15 inches: 1 pound per month
or largemouth bass under 15 inches: 2 pounds per month
or channel catfish over 24 inches: 1 pound per month
or channel catfish under 24 inches: 3 pounds per month
or crappie over 12 inches: 1 pound per month
or crappie under 12 inches: 3 pounds per month
or all white catfish: 3 pounds per month
or all brown bullhead: 6 pounds per month
or all Sacramento blackfish: 6 pounds per month
or all hitch: 10 pounds per month

OR

Lake Berryessa (Napa County)

Largemouth bass over 15 inches: 1 pound per month
or largemouth bass under 15 inches: 2 pounds per month
or all smallmouth bass: 1 pound per month
or all channel catfish: 3 pounds per month
or all white catfish: 2 pounds per month
or all rainbow trout: 10 pounds per month

OR

Lake Herman (Solano County)

All largemouth bass: 1 pound per month